The Distant Type Ia SN Rate

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for the Supernova Cosmology Project

http://supernova.lbl.gov

Data sets

4 independent CTIO-4m data sets from SCP (cosmological parameters) :

- set A: fall 95, 68 2kx2k, 0.43"/pixel

- set B: spring 96, 46 2kx2k, 0.43"/pixel

- set C: spring 97, 15 BTC, 4x2kx2k, 0.43"/pixel

- set D: fall 97, 11 BTC, 4x2kx2k, 0.43"/pixel

2 x 600 s exposures x 2 - R_{lim} = 22.5-24.5

Total solid angle = 12 square degrees

Methodology

Three main parts:

- Nb of SN Ia

- Control Time (SN detection efficiency)

- Volume surveyed or/and galaxy luminosity

$$\text{Rate} = \frac{\text{Nb of SN}}{\text{Volume/Luminosity x Control Time}}$$

Rate per unit Vol $\Rightarrow h^3 \, Mpc^{-3} \, yr^{-1}$

Rate per unit Lum $\Rightarrow h^2 \, SNu$

$$(1 \, SNu = 1 \, SN/10^{10} L_{Bsun}/100 \, yr)$$

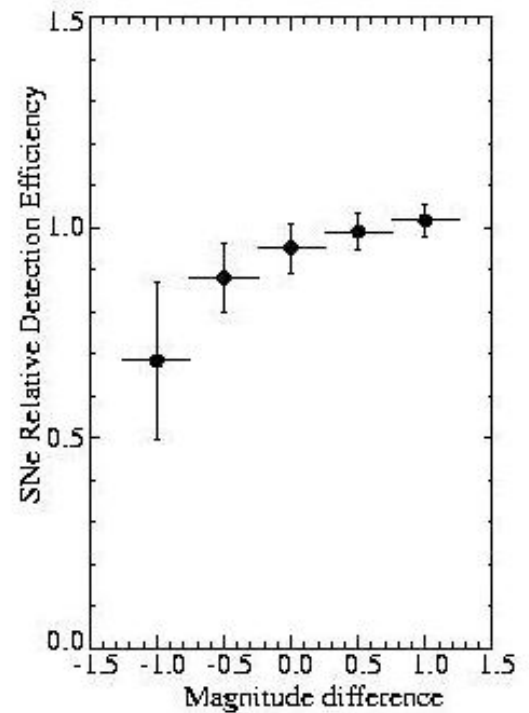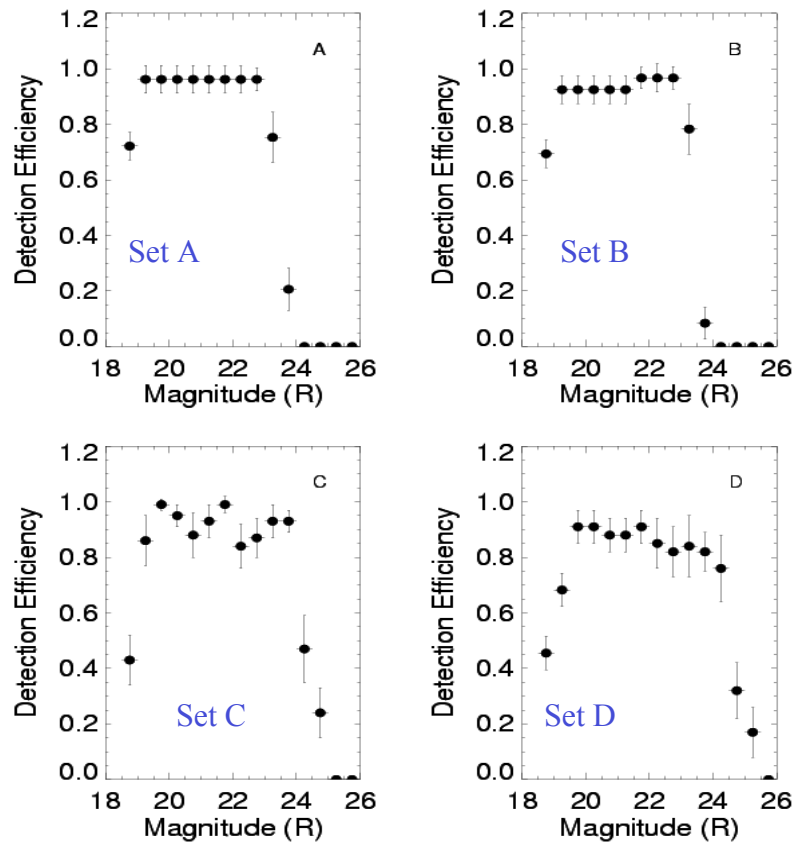# Detection of supernovae

A 2 steps process on image subtractions:

- Selection of transients events:

  - S/N>5 (S/N>3.5 in the original search)

  - $\text{flux}_{SN}/\text{flux}_{gal} > 0.15$

- Rejection of :

  - stat fluct., cosmics, asteroids with coincidences on split images

  - Hot/dead pixels, flatfield defects, bad subtractions with visual inspection of subs

Detection efficiencies

Computed adding fake SN (stars) on real images (galaxies)

SN/galaxy relative brightness

Identification of SNe Ia

Obtain spectrum for every event that passes the cuts:

4 "non SN" (QSO/AGN) and 53 "supernovae" with :

- 12 events below high threshold (S/N>5)
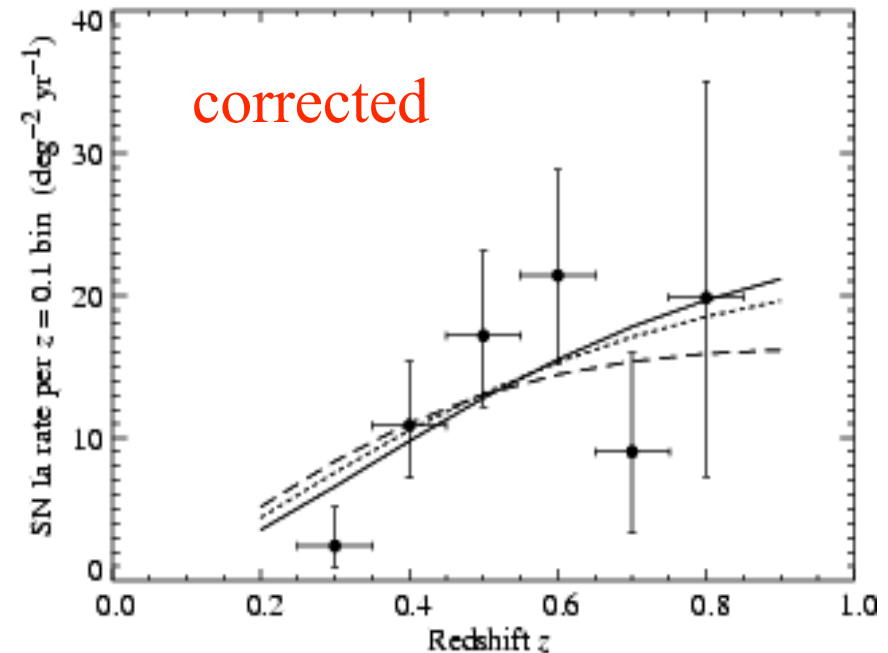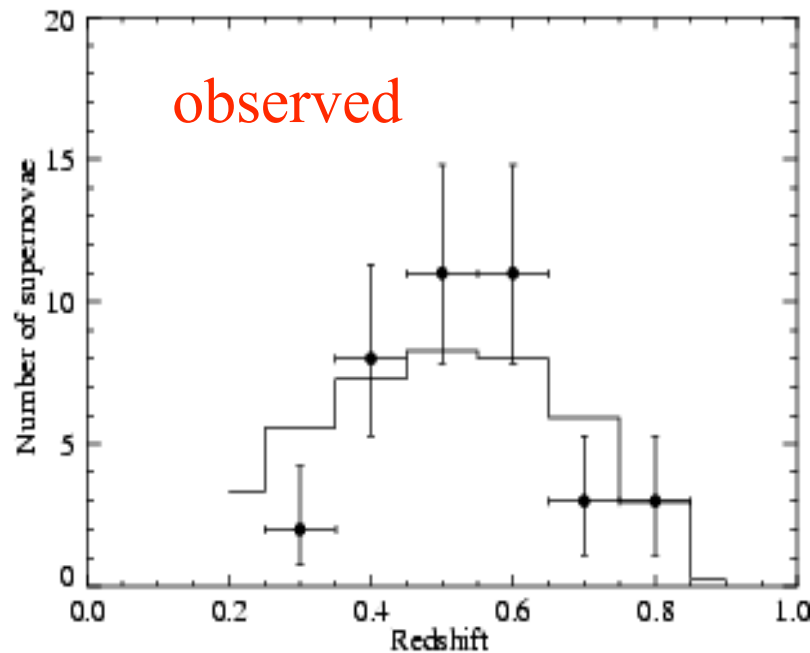
- 5 identified as "non Ia" (II/QSO or II/AGN or Ib/c)

=> 37 "possible SN Ia" with :

- 28 identified as Ia (SiII/SII "W"/CaII H&K,..)

-   9 identified as "probable Ia" (I + LC, host, stat,...)

(see SCP poster on SN spectroscopy for more about
  SN identification)

Rate per unit comoving volume

1 - Compute the expected nb of SN Ia vs redshift

2 - fit to the observed distribution (left plot)

3 - Compute the nb of SN Ia per sq deg per yr vs redshift

Systematic Uncertainties

We estimated systematics from :

- Detection efficiencies/identification (~10%)

- Range of Ia Lightcurves   (~10%)

- Field calibration

- Cluster contribution

- Galaxy extinction

- Luminosity estimate (~10%)

No estimate made of systematics from host
   galaxy inclination or extinction

Results

Using: $\Omega_M = 0.28^{+0.10}_{-0.09}$ ($\Omega_{Tot}=1$)

We obtain:

syst.

stat.

$R_L = 0.58^{+0.28\ +0.32}_{-0.25\ -0.31}$ h^2 SNu

and :

$R_V = 1.53^{+0.28\ +0.32}_{-0.25\ -0.31}$ 10^{-4} h^3 Mpc^{-3} yr^{-1}